



Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education (9–1)

CHEMISTRY

0971/22

Paper 2 Multiple Choice (Extended)

October/November 2019

45 minutes

Additional Materials: Multiple Choice Answer Sheet
 Soft clean eraser
 Soft pencil (type B or HB is recommended)



READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO NOT WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

This document consists of **15** printed pages and **1** blank page.

- 1 The rate of diffusion of a gas depends on its molecular mass and the temperature.

Which combination of molecular mass and temperature gives the slowest rate of diffusion?

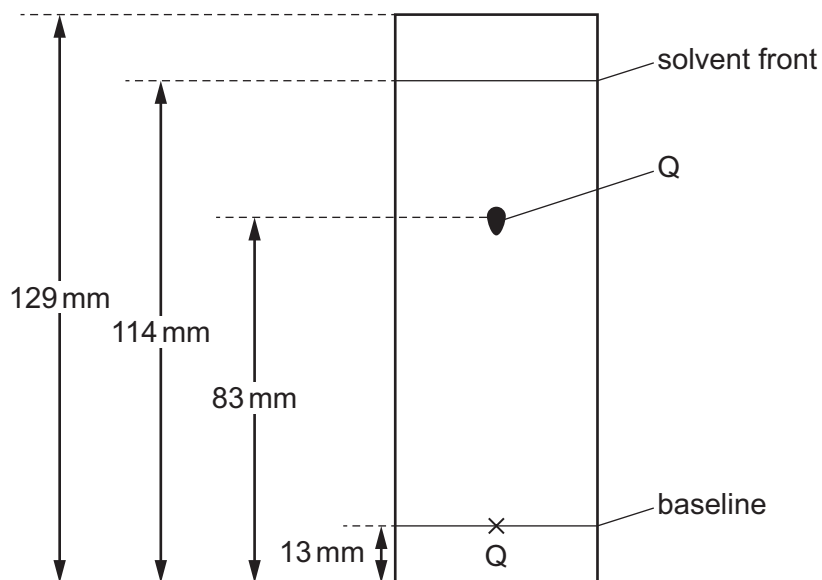
	molecular mass	temperature
A	high	high
B	high	low
C	low	high
D	low	low

- 2 A student is asked to measure the time taken for 0.4g of magnesium carbonate to react completely with 25.0 cm³ of dilute hydrochloric acid.

Which pieces of apparatus does the student need?

- A** balance, stop-clock, pipette
B balance, stop-clock, thermometer
C balance, pipette, thermometer
D stop-clock, pipette, thermometer
- 3 Substance Q was investigated using chromatography.

The chromatogram is shown. The diagram is not drawn to scale.



What is the R_f value of Q?

- A** 0.60 **B** 0.64 **C** 0.69 **D** 0.72

- 4 Which statement about an ionic compound is **not** correct?
- A It conducts electricity when dissolved in water.
 - B It has a high melting point due to strong attractive forces between ions.
 - C It has a regular lattice of oppositely charged ions in a 'sea of electrons'.
 - D The ionic bonds are formed between metallic and non-metallic elements.

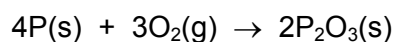
- 5 What is the total number of electrons in one molecule of ammonia, NH₃?
- A 6 B 8 C 10 D 11

- 6 Rubidium has two isotopes, $^{85}_{37}\text{Rb}$ and $^{87}_{37}\text{Rb}$.

Which statement explains why both isotopes have the same chemical properties?

- A They have the same number of protons.
 - B They have the same number of outer shell electrons.
 - C They have different numbers of neutrons.
 - D They have different mass numbers.
- 7 Which statement about the structure and properties of silicon(IV) oxide is **not** correct?
- A It has a giant structure similar to that of diamond.
 - B It has a high melting point due to the strong attractive force between molecules.
 - C There are strong covalent bonds between silicon and oxygen.
 - D There are no free electrons, so silicon(IV) oxide does not conduct electricity.
- 8 Which statement describes the structure of copper?
- A It has a lattice of negative ions in a 'sea of electrons'.
 - B It has a lattice of negative ions in a 'sea of protons'.
 - C It has a lattice of positive ions in a 'sea of electrons'.
 - D It has a lattice of positive ions in a 'sea of protons'.

- 9 Phosphorus reacts with oxygen to form phosphorus(III) oxide as shown.



Which mass of phosphorus(III) oxide is produced from 6.2 g of phosphorus?

- A 1.1 g B 5.5 g C 11.0 g D 22.0 g

- 10 Calcium carbonate is heated. Calcium oxide and carbon dioxide gas are formed.

The equation for the reaction is shown.

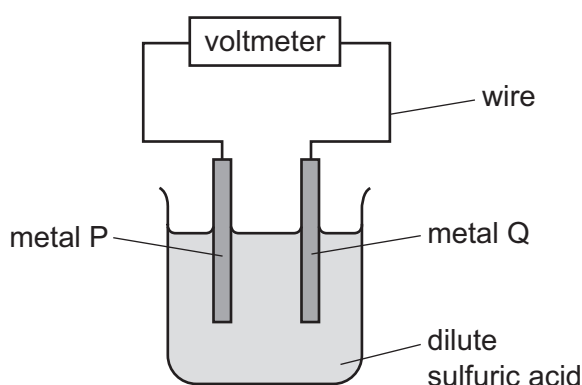


225 kg of calcium carbonate is heated until there is no further change in mass.

The yield of calcium oxide is 85 kg.

What is the percentage yield?

- A** 37.8% **B** 47.2% **C** 67.5% **D** 85.0%
- 11 The diagram shows a simple cell.



Which pair of metals produces the largest voltage?

	metal P	metal Q
A	magnesium	iron
B	magnesium	copper
C	zinc	iron
D	zinc	copper

- 12 What are the ionic half-equations for the electrode reactions during the electrolysis of concentrated aqueous sodium chloride?

	anode	cathode
A	$\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$	$\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$
B	$2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$	$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$
C	$\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$	$\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$
D	$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$	$2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$

13 The temperature of the water in two beakers, X and Y, is measured as 21.5 °C.

5g of sodium chloride is dissolved in the water in beaker X. The temperature changes to 18.0 °C.

5g of calcium oxide is dissolved in the water in beaker Y. The temperature changes to 29.4 °C.

Which types of process are occurring in beakers X and Y?

	X	Y
A	endothermic	endothermic
B	endothermic	exothermic
C	exothermic	endothermic
D	exothermic	exothermic

14 Which gases are used to generate electricity in a fuel cell?

- A** carbon dioxide and oxygen
- B** hydrogen and methane
- C** hydrogen and oxygen
- D** methane and carbon dioxide

15 Which row identifies a chemical and a physical change?

	chemical change	physical change
A	boiling ethanol	burning ethanol
B	burning ethanol	evaporating ethanol
C	dissolving ethanol in water	burning ethanol
D	evaporating ethanol	dissolving ethanol in water

- 16** A sample of dilute nitric acid is added to lumps of limestone in a conical flask. The conical flask is placed on a balance and the loss in mass is measured.

A second sample of nitric acid of a different concentration is separately tested. All other conditions are kept the same.

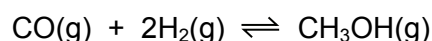
The loss in mass in 1 minute at each concentration of nitric acid is shown.

concentration in mol/dm ³	loss in mass in 1 minute/g
0.5	0.15
1.0	0.25

Which row describes and explains the results obtained using 1.0 mol/dm³ nitric acid compared with 0.5 mol/dm³ nitric acid?

	description	explanation
A	decrease in reaction rate	decrease in particle collision energy
B	decrease in reaction rate	increase in particle collision rate
C	increase in reaction rate	increase in particle collision rate
D	increase in reaction rate	increase in particle collision rate and collision energy

- 17** When carbon monoxide reacts with hydrogen, methanol is formed.



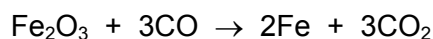
The forward reaction is exothermic.

Which statements are correct?

- 1 There are more moles of gas on the left-hand side of the reaction.
- 2 Increasing the temperature increases the amount of methanol at equilibrium.
- 3 Increasing the pressure increases the amount of methanol at equilibrium.
- 4 Increasing the initial amount of hydrogen decreases the amount of methanol at equilibrium.

- A** 1 and 2 only **B** 1 and 3 only **C** 2 and 4 only **D** 3 and 4 only

- 18 In the blast furnace, iron is formed when iron(III) oxide reacts with carbon monoxide in a redox reaction.



Which substance is the oxidising agent and which substance is the reducing agent?

	oxidising agent	reducing agent
A	CO	Fe ₂ O ₃
B	CO ₂	Fe
C	Fe	CO ₂
D	Fe ₂ O ₃	CO

- 19 Which oxide is classified as an amphoteric oxide?

- A** aluminium oxide
- B** calcium oxide
- C** copper(II) oxide
- D** nitrogen oxide

- 20 Which statement describes the properties of hydrochloric acid?

- A** Carbon dioxide is produced when limestone reacts with hydrochloric acid.
- B** Hydrogen is produced when sodium hydroxide reacts with hydrochloric acid.
- C** Methyl orange turns yellow in strong hydrochloric acid.
- D** Red litmus paper turns blue when dipped into hydrochloric acid.

21 A method used to make copper(II) sulfate crystals is shown.

- 1 Place dilute sulfuric acid in a beaker.
- 2 Warm the acid.
- 3 Add copper(II) oxide until it is in excess.
- 4 Filter the mixture.
- 5 Evaporate the filtrate until crystals start to form.
- 6 Leave the filtrate to cool.

What are the purposes of step 3 and step 4?

	step 3	step 4
A	to ensure all of the acid has reacted	to obtain solid copper(II) sulfate
B	to ensure all of the acid has reacted	to remove the excess of copper(II) oxide
C	to speed up the reaction	to obtain solid copper(II) sulfate
D	to speed up the reaction	to remove the excess of copper(II) oxide

22 Lead(II) sulfate is an insoluble salt.

Which reaction produces a mixture from which lead(II) sulfate is obtained by filtration?

- A** adding solid lead(II) carbonate to dilute sulfuric acid
- B** adding solid lead(II) hydroxide to dilute sulfuric acid
- C** adding metallic lead to dilute sulfuric acid
- D** adding aqueous lead(II) nitrate to dilute sulfuric acid

23 Helium is a noble gas.

Which statement about helium is correct?

- A** It has eight electrons in its outer shell.
- B** It is a diatomic gas.
- C** It is reactive.
- D** It is used for filling balloons.

24 Which pair of elements reacts together most violently?

- A chlorine and lithium
- B chlorine and potassium
- C iodine and lithium
- D iodine and potassium

25 Iron(II) ions can be oxidised to iron(III) ions by hydrogen peroxide.

Which statement explains why iron is a transition element?

- A Iron is a transition element because it can be oxidised.
- B Iron is a transition element because it has variable oxidation states.
- C Iron is a transition element because it takes part in redox reactions.
- D Iron is a transition element because it reacts with chlorine.

26 Some properties of substance X are listed.

- It conducts electricity when molten.
- It has a high melting point.
- It burns in oxygen and the oxide dissolves in water to give a solution with pH 11.

What is X?

- A a covalent compound
- B a macromolecule
- C a metal
- D an ionic compound

27 Which row describes the uses of aluminium, copper and mild steel?

	aluminium	copper	mild steel
A	aircraft bodies	electrical wiring	car bodies
B	car bodies	cooking utensils	electrical wiring
C	electrical wiring	aircraft bodies	food containers
D	food containers	aircraft bodies	cooking utensils

28 The properties of four metals are listed.

- Metal W does not react with dilute hydrochloric acid.
- Metal X reacts with dilute hydrochloric acid.
- Metal Y displaces metal X from an aqueous solution of its ions.
- Metal Z reacts with water and dilute hydrochloric acid.

What is the order of reactivity of the metals?

	most reactive	→			least reactive
A	W	X	Y	Z	
B	W	Y	X	Z	
C	Z	X	Y	W	
D	Z	Y	X	W	

29 Which statement about the extraction of aluminium from aluminium oxide is correct?

- A** Aluminium is formed at the positive electrode during electrolysis.
- B** Pure aluminium oxide is dissolved in molten cryolite.
- C** Pure aluminium oxide is electrolysed using aluminium as the positive electrode.
- D** Pure aluminium oxide is heated with carbon to form carbon dioxide and aluminium.

30 River water contains soluble impurities, insoluble impurities and bacteria.

River water is made safe to drink by filtration and chlorination.

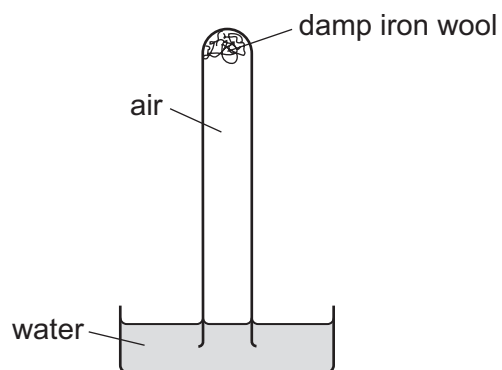
Which statement is correct?

- A** Filtration removes bacteria and insoluble impurities, and chlorination removes soluble impurities.
- B** Filtration removes insoluble impurities, and chlorination kills the bacteria.
- C** Filtration removes soluble and insoluble impurities, and chlorination kills the bacteria.
- D** Filtration removes soluble impurities and bacteria, and chlorination removes insoluble impurities.

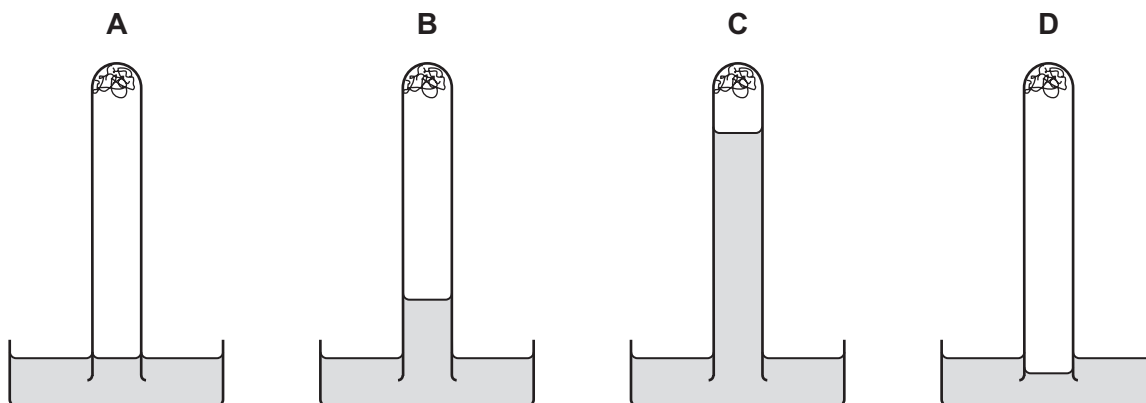
31 Which process is used to separate nitrogen and oxygen from air?

- A chromatography
- B evaporation
- C filtration
- D fractional distillation

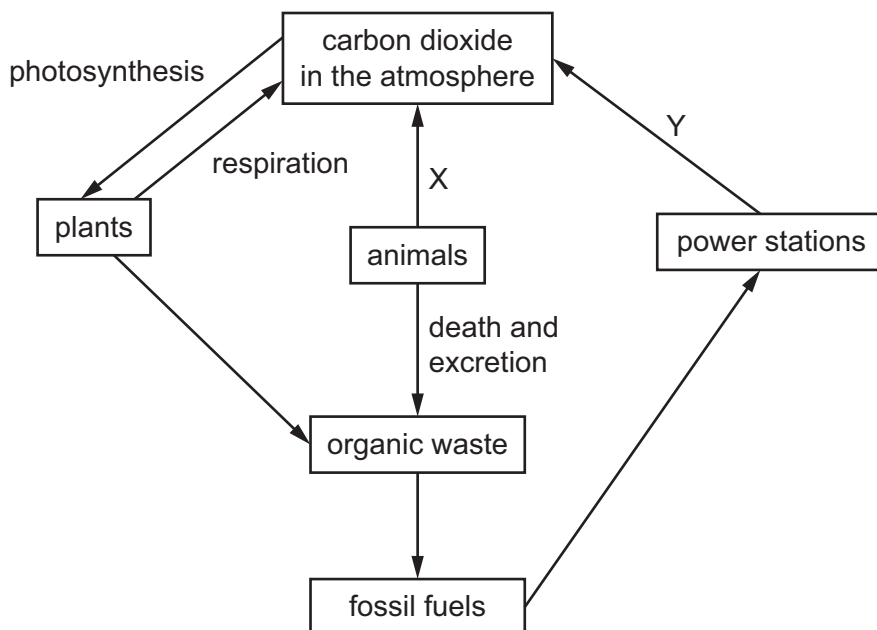
32 The apparatus shown is set up and left for a week.



Which diagram shows the level of the water at the end of the week?



33 The diagram represents an outline of the carbon cycle.



Which processes are X and Y?

	X	Y
A	combustion	respiration
B	decomposition	respiration
C	photosynthesis	combustion
D	respiration	combustion

34 Ammonium sulfate is used as a fertiliser.

It is made from ammonia and sulfuric acid.

Which words complete gaps 1, 2 and 3?

The1..... is made by the2..... process in which3..... is used as a catalyst.

	1	2	3
A	ammonia	Contact	iron
B	ammonia	Haber	vanadium(V) oxide
C	sulfuric acid	Contact	vanadium(V) oxide
D	sulfuric acid	Haber	iron

35 Which statement about limestone and lime is correct?

- A Limestone combines with water to produce slaked lime.
- B Lime is obtained from limestone by oxidation.
- C Lime is used in the desulfurisation of flue gases.
- D Lime is used in the treatment of alkaline soil.

36 Some fractions obtained from petroleum are listed.

	fraction	use	position collected in the fractionating column
1	gasoline	waxes and polishes	below refinery gas
2	bitumen	making roads	above kerosene
3	kerosene	jet fuel	below gasoline
4	refinery gas	heating and cooking	above gasoline

Which rows are correct?

- A 1, 3 and 4
- B 2, 3 and 4
- C 3 and 4 only
- D 4 only

37 Which products are obtained by the cracking of an alkane?

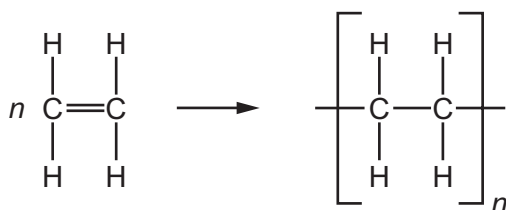
	alkene	hydrogen	water
A	✓	✓	✓
B	✓	✓	x
C	✓	x	✓
D	x	✓	✓

38 Ethanol is produced by fermentation or by the reaction of ethene with steam.

Which row is correct?

	by fermentation	from ethene
A	uses a temperature of 100 °C	uses a temperature of 350 °C
B	needs yeast as a catalyst	does not need a catalyst
C	very slow reaction	very fast reaction
D	high yield of ethanol	low yield of ethanol

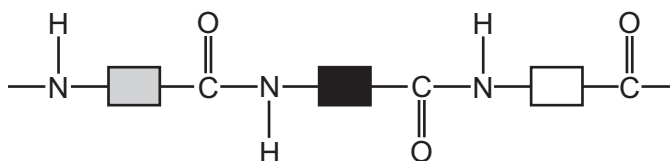
39 The diagram shows the structure of a monomer and of the polymer made from it.



What are the monomer and polymer?

	monomer	polymer
A	ethane	poly(ethane)
B	ethane	poly(ethene)
C	ethene	poly(ethane)
D	ethene	poly(ethene)

40 The structure of a naturally occurring polymer, X, is shown.



What is X?

- A** an amino acid
- B** a carbohydrate
- C** a protein
- D** a sugar

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The Periodic Table of Elements

Group																																					
I	II	Key										III	IV	V	VI	VII	VIII																				
3	4	atomic number atomic symbol name relative atomic mass																2																			
Li lithium 7	Be beryllium 9	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																		
Na sodium 23	Mg magnesium 24	H hydrogen 1	He helium 4	B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20	Al aluminium 27	Si silicon 28	P phosphorus 31	S sulfur 32	Cl chlorine 35.5	Ar argon 40	K potassium 39	Ca calcium 40	Sc scandium 45	Ti titanium 48	V vanadium 51	Cr chromium 52	Mn manganese 55	Fe iron 56	Co cobalt 59	Ni nickel 59	Cu copper 64	Zn zinc 65	Ga gallium 70	Ge germanium 73	As arsenic 75	Se selenium 79	Br bromine 80	Kr krypton 84				
Rb rubidium 85	Sr strontium 88	55	56	57-71 lanthanoids	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89-103 actinoids	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118
Cs caesium 133	Ba barium 137	Fr francium —	Ra radium —	La lanthanum 139	Ce cerium 140	Pr praseodymium 141	Nd neodymium 144	Pm promethium —	Sm samarium 150	Eu europium 152	Gd gadolinium 157	Tb terbium 159	Dy dysprosium 163	Ho holmium 165	Er erbium 167	Tm thulium 169	Yb ytterbium 173	Lu lutetium 175	Ac actinium —	Th thorium 232	Pa protactinium 231	U uranium 238	Np neptunium —	Pu plutonium —	Am americium —	Cm curium —	Bk berkelium —	Cf californium —	Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —	Rn radon —			

lanthanoids	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
	lanthanum 139	cerium 140	praseodymium 141	neodymium 144	promethium —	samarium 150	europium 152	gadolinium 157	terbium 159	dysprosium 163	holmium 165	erbium 167	thulium 169	ytterbium 173	lutetium 175
actinoids	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
	actinium —	thorium 232	protactinium 231	uranium 238	neptunium —	plutonium —	americium —	curium —	berkelium —	californium —	einsteinium —	fermium —	mendelevium —	nobelium —	lawrencium —

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).